TOWARDS A WORLD WITHOUT HUNGER

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FOREWORD

This paper was presented at an International Symposium entitled "Decision Makers' Search for Viable Options in an Interdependent World", which was organized by the Gottlieb Duttweiler Institute from June 20-22, 1983 in Rueschlikon/Zurich, Switzerland

The objectives of the Food and Agriculture Program are to:

- to evaluate the nature and dimensions of the world food situation
- to identify factors affecting it
- to suggest policy alternatives at national, regional and global levels in order to alleviate current food problems and to prevent food problems in the future.

The major food problem of the world is inadequate food consumption by large numbers of people in the world.

This paper describes the problem and conceptual framework for policy analysis for it that can be used for exploring alternative policies with the system of linked national agricultural policy analysis developed by the Food and Agriculture Program

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1. Hunger, a Widespread Persistent Problem

Chronic hunger is a widespread and a persistent problem. It has plagued mankind for centuries and even amidst the unprecedented prosperity of the 20th century it exists on a large scale. Though in recent years national and international actions have more or less been able to avoid deaths due to famines, chronic hunger has persisted as a silent tragedy of millions. There is enough food in the world to feed all and what is more there is enough food in many countries who have many hungry people and yet hunger persists. It is a problem of poverty and inadequate income to buy food. The inequality of income distributions in most developing countries leaves the poor hungry. Faster economic and agricultural growth and slower growth of population with redistributive policies may seem to be the obvious answers. But these have been hard to attain. Hunger has been a stubborn problem that has persisted in spite of many efforts, national and international, to eradicate it. The failure of many of these efforts has generated cynicism and controversies on the ways the problem ought to be tackled. Can global modeling help throw some light on policy options?

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*I am thankful to my colleagues Klaus Frohberg, Mahendra Shah, and Robert Thompson for valuable comments on an earlier draft.

2. The Nature of the Problem

2.1. Hunger is widespread

That hunger is widespread is obvious from the number of people in absolute poverty. Although estimates vary, they all indicate a sizeable problem. In 1980 for developing countries, excluding China and other centrally planned economies, the World Development Report (The World Bank, 1980) estimated that approximately 780 million people did not have enough income to buy "adequate* food" and minimum of clothing. The FAO estimates indicate that in 1972-74, 455 million people in these developing countries had a food intake below the critical limit of 1.2 times the basal metabolic rate (BMR).

Given the considerable uncertainties in prescribing norms for calorie requirements, it is difficult to arrive at precise estimates of the number of hungry people in the world. Yet one may look upon a calorie norm as a norm incorporating value judgment rather than an objective physiologically prescribed need, and classify people below the norm as "hungry" or "in poverty". Though the methodologies of estimating the extent of hunger are unsatisfactory and the estimates they generate are questionable for their accuracy it is worth looking at them if only to get an idea of the order of magnitude involved. Thus, even if these estimates are off by 100% from the true values we are still left with 200 to 300 million hungry people.

2.2. Chronic hunger is persistent

That hunger is persistent and enduring can be seen from the estimates of the percentage of the rural population, defined as those whose consumption was inadequate to provide a stipulated calorie consumption, in "absolute poverty" in India, which has a large proportion of the world's poor. The data in Table 1 show that there has been no significant trend in the percentage

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*"adequacy" defined on the basis of an implicit nutritional norm

of the rural population in poverty over the period 1959-1974. This is so in spite of India's successful development of agriculture which has grown at a faster rate than population during this period.

Table 1. Percentage of Rural Population in Poverty in India (1959-1974).

Year	59-60	61-62	64-65	66-67	68-69	73-74
India (weighted averages)	49	42	50	57	53	48

Source: Ahluwalia, M.S. (1978) Rural Poverty and Agricultural Performance in India, Journal of Development Studies, Vol. 14, April 1978, pp.298-323.

2.3. Though widespread, hunger can be eradicated with only marginal resources

Assuming that 800 million people are hungry in the world and that their average calorie deficit is 350 calories per day, around 30 million tonnes of foodgrains per year is all that would be needed to eradicate hunger if we can distribute food to those who are hungry. This is less than 2 percent of world's grain production in 1980. In value terms this is less than a day or two's military expenditure in the world which is more than a billion dollars a day. Yet the question remains how do we get this food to the poor who need it?

2.4. Hunger has persisted in spite of many efforts

Industrialized countries have been giving substantial food aid over the years. The food aid given in 1980 by developed western countries alone amounted to 2.6 billion dollars, as shown in Table 2, almost enough to buy 15 to 20 million tonnes of food grain. Yet hunger persists. This has led many people to raise questions regarding the efficacy of food aid, at least in the way it is administered. (For a somewhat polemical, impressionistic and not always very rigorous but still thought-

Table 2. Food Aid from Western Donors, 1980, in Millions of Dollars.

	Bilateral loans	Bilateral grants	Multilateral grants	Total
Australia	–	38.7	25.3	64.0
Austria	–	–	2.6	2.6
Belgium	–	5.2	34.1	39.3
Canada	2.5	76.0	86.3	164.8
Denmark	–	2.4	42.6	45.0
Finland	–	–	4.2	4.2
France	–	38.1	84.7	122.8
Germany	–	61.1	152.6	213.7
Italy	–	21.2	54.6	75.8
Japan	206.3	12.8	42.2	261.3
Netherlands	–	26.6	76.6	103.2
New Zealand	–	–	0.9	0.9
Norway	–	0.4	21.9	22.3
Sweden	–	7.7	39.5	47.2
Switzerland	–	15.8	12.1	27.9
United Kingdom	–	21.4	95.5	116.9
United States	687.0	471.0	149.0	1307.0
			TOTAL	2618.9

Of the food aid provided by EEC member states, the EEC as an entity disbursed $275,500,000 on a bilateral grant basis and $161,400,000 on a multilateral grant basis, for a total of $436,900,000.
Source: *1981 Review: Development Co-operation*, OECD, Paris, 1981, Table A.10.

provoking questioning of food aid see Tony Jackson's (1983) book "Against the Grain".) Moreover, such "food aid" is unreliable as it is mainly surplus disposal associated with domestic price support operations. "Food aid" availability sharply fell at the time of the 1973/74 "world food crisis"!

2.5. There is adequate food in the world

Hunger exists in spite of the fact that there is adequate food in the world. That globally adequate food is available can be seen in Table 3. All developed regions have adequate food supplies. The developing countries as a group are producing inadequate or barely adequate (considering the uncertainty of the norms) food supplies. Although the situation is improving, it is improving only slowly.

Table 3. Per Capita Daily Supply of Calories.

Region	Calorie Supply				Supply as Percentage of Requirement*			
	1961-63	1964-66	1969-71	1972-74	1961-63	1964-66	1969-71	1972-74
	Kilocalories per Capita				Percentage			
Developed Market Economies	3.130	3.170	3.280	3.340	123	124	129	131
Eastern Europe and the USSR	3.240	3.270	3.420	3.460	126	127	133	135
Developing Market Economies	2.110	2.130	2.190	2.180	92	93	96	95
Asian Centrally Planned Economies	1.960	2.110	2.220	2.290	83	90	94	97
All Developing Countries	2.060	2.120	2.200	2.210	89	92	95	96
World	2.410	2.460	2.540	2.550	101	103	106	107

*FAO stipulated calorie requirements are 1.2 times the BMR (Basal Metabolic Rate).
Source: The Fourth World Food Survey, 1977. Table 1.3.1, page 16. FAO, 1977.

2.6. Stepping up food production in developing countries - difficulties, needs, and problems

Increased food production in food deficient countries may seem to be the obvious answer to meeting the problem of hunger. Yet production increases indicated by trend rates in the developing countries would be inadequate and in fact would lead to reduced self-sufficiency in food production. This can be seen from the FAO's projections given in Table 4. Though average consumption increases, the reduction in the number of undernourished people is marginal. The cereal imports of deficit countries increase dramatically. To offset the agricultural commodity trade balance, these countries would have to increase their exports of nonagricultural products substantially. In order to accomplish this, national governments would have to step up their efforts to create faster economic growth. This in turn can lead to increased import needs for capital goods and can aggravate the balance of payments. Moreover, expansion of such exports may not be easy to achieve without a change in the international economic order.

To step up agricultural growth rates in developing countries beyond the trend rates, increased availability of inputs and

Table 4. FAO's AT 2000 projections for 90 developing countries based on trend rates.

	1980	2000
Aggregate calorie self-sufficiency ratio	0.92	0.80
Cereal imports of deficit countries	47 m. tons	180 m. tons
Net meat deficit	−0.4*m. tons	14 m. tons
Agri. commodity net trade balance (1975 billion $)	6 billion $	−36 billion $
Average calorie consumption per person per day	2278 calories	2489 calories
Population undernourished	415*m. (22%)	390 m. (11%)

*1974–75

Source: Agriculture: Toward 2000. FAO, c79-24, November 1979.

capital resources is required. Table 5 summarizes these needs for selected inputs for FAO's normative scenario projections. Realization of such growth rates would call not only for increased availability of inputs and capital resources but also for appropriate national policies which persuade the producers to produce more. Redistributive policies to bring about a more equitable distribution of food are also largely matters of national policies.

The FAO projection methodology is based mainly on technological considerations of input requirements for obtaining different outputs. The questions of appropriate government policies as well as of consistency of production, income, and demand are not explored in the FAO study.

Table 5. Production and key inputs for 90 developing countries. (Index, 1975 = 100 unless otherwise stated)

			Annual growth rates	
	1980	2000	1963–1975	1980–2000
Gross value of agri. production	115	244	2.6	3.0
Gross value of crop production	114	232	2.6	3.6
Arable area (million ha)	744	936	0.8	1.2
Irrigated area (million ha)	104	152	2.0	1.9
Yield	112	181	1.8	2.4
Fertilizer (million tons – nutrients)	19	94	11.8	8.2
Tractors (thousands)	2327	9860	7.7	7.5
Gross value of livestock production	115	288	2.9	4.7
Cereal feed (million tons)	57	190	5.4	6.2

Source: Agriculture: Toward 2000. FAO, c79-24, November 1979.

2.7. Importance of income distribution

The importance of considering income distribution in assessing the adequacy of food consumption within a country can be seen in Table 6, which shows the distribution of daily calorie consumption for India. It can be seen that in 1973-74, 38% of the population had a deficit in daily calorie consumption, although for the country as a whole there was no calorie deficit. Moreover, the problem for the poorest classes is severe, as 5% of the population had a deficit of 1100 calories/person/day, and another 5% had a deficit of 680 calories/person/day.

A similar picture emerges from data for Kenya given in Table 7. For the country as a whole there is only a marginal calorie deficit, yet 40% of the rural population have a daily calorie deficit of 640 calories, and in urban areas 40% have a deficit of 340 calories.

After this look at the nature of the problem we should ask why are some countries poor and others rich? Why is there a hunger problem in India but not in the Netherlands? It is not just because of growing population in India, because still the density of population in India is less than in the Netherlands.

Table 6. India, 1974 - Distribution of Calorie Consumption.

Income class	Percentage of total population	Daily calorie consumption per person	Daily calorie deficit per person
1	5	1102	1108
2	5	1528	682
3	10	1647	563
4	18	1904	306
5	20	2115	-
6	21	2495	-
7	11	2805	-
8	7	3140	-
9	3	3440	-
Total	100	2217	-

Based on National Sample Survey, 28th round, October 1973 to June 1974.

Table 7. Kenya, 1975 - Distribution of Calorie Consumption.

Income class	Percentage of total population	Daily calorie consumption per person	Daily calorie deficit per person*
Rural			
1	39	1578	642
2	32	2077	143
3	19	2545	-
4	5	2867	-
5	2	2788	-
6	4	3036	-
Total	100	2069	151
Urban			
1	42	1787	343
2	25	2117	13
3	33	2453	-
Total	100	2086	44

*Moderately active rural requirement 2200 calories per day.
Urban light activity requirement 2130 calories per day.
Source: M. M. Shah, Calorie Demand Projections Incorporating Urbanization and Income Distribution. FAP, IIASA, 1978.

Why don't the developing countries increase their growth rates and redistribute incomes? To what extent is the problem of hunger in the LDC's of their own making? Have they neglected agriculture or is there not enough scope for development of agriculture? Have they been too callous of the suffering of their own poor or have the LDC's persued well meaning but ineffective policies? Are their strategies for development sensible? Are the policy options of the developing countries affected by the policies of the DC's? To what extent DC policies have restricted LDC policy options? What can the developed

countries do to make it possible and easier for the LDC's to provide food for all, now and in the future?

To identify policies that could make an impact on hunger, we have to understand the working of national agricultural systems embedded in national economies and interacting with each other through trade and transfers. The self-interest, the power and the freedom of decision making of the participants cannot be neglected, be they the rich within a country or the powerful nations outside.

It is in such a framework that the FAP of IIASA has been trying to understand the nature of the world food system to explore food policy options for growth with redistribution, for food security and stability in an interdependent world.

3. The Food and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA): Search for Understanding and Options

The Food and Agriculture Program (FAP) of IIASA* has been engaged in the development of a global model comprising a set of linable national models for agricultural policy analysis since 1976 with the help of a network of collaborating institutions around the world. The purpose of the FAP is to study the effect on the domestic food situation in given countries of alternative policy measures as taken by their own governments, by the governments of other countries and by international organizations which operate under specified international agreements.

4. FAO's Approach to Policy Analysis

FAP recognizes that the world food system is not a goal-oriented, single-purposed system with a world government as a

*Parikh Kirit and Rabar Ferenc (eds.) Food for All in a Sustainable World. Status Report, IIASA, Laxenburg, Austria, August 1981.

decision maker. It is a system of national economies interacting with each other through trade under the influence of the policies of national governments. The national governments with their different resources and different interests play against each other the game of international trade. But the nations are not equal in this game of international interactions. Some command more resources, more land, more capital, more knowledge and more power. Similarly within nations, different groups persue their own interests and their interaction produces the outcome of the national system. The interactions of the national systemsproduce the outcome of the world system.

The emphasis has been on policy analysis. For realistic policy analysis one must consider policy instruments and actions which can be identified with specific decision makers. Thus government is an important actor in our system. Moreover, policies to be effective, should account for the fact that various economic agents adjust their behavior in response to policies. Thus we have to distinguish various economic agents and describe accurately their behavioral responses. This approach is followed both at the national level as well as at the international level. At the national level, the actors comprise various types of farmers and non-farmers and the national government. At the international level the national governments constitute the various actors.

This basic approach* permits analysis of a wide range of government policies. These include domestic price policies including price supports and input subsidies, quantity rationing, trade restrictions, strategic reserve policies, normative consumption and income policies, plan target realization and self-sufficiency policies as well as free market policies. Depending on the particular set of policies and the hierarchy of policy adjustment that is prescribed one can characterize equally well market economies, socialist economies and mixed economies. This is so because the only constraints imposed are the accounting rules and all economies have to respect these accounting identities.

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*Keyzer Michiel, "The International Linkage of Open Exchange Economies". Doctoral Dissertation, Free University of Amsterdam, 1981.

The accounting identities are similar in nature to the laws of conservation, i.e. you can't get more from the system than what you put in. The model needs to cover the whole system and not leave any unaccounted supply sources or demand sinks which can mask feedbacks and secondary, but not negligible, effects. Thus at the national levels we consider the whole economy and include along with agriculture, also the non-agriculture sector. Similarly, at the international level we include the whole world by including an aggregated model for the countries not included in our system.

In summary we can characterize the FAP system of linked models as one that provides a quantitative tool for exploring alternative policy strategies applicable to various kinds of economies, planned as well as market economies, and which is realistic in the sense that it takes into account the behavioral response of the various actors in the economy. Moreover, the system constitutes a powerful tool for analyzing interdependencies of policies of different countries and issues of trade policies. For exploring policies for growth of agriculture, one needs to quantify the supply responses of farmers to various policy instruments. For exploring distribution policies one needs to characterize consumer behavior under the influence of government policies. For exploring the interactions of growth and equity one needs to specify the income generation and distribution process as well as recognize the limitations of government policies and constraints on their consistency. The typical national model of FAP does this.

From a purely analytical point of view, one should not lose sight of the innovative character of the FAP approach. Virtually all international modeling systems have geographically divided the world into a limited number of broad regions. As policy decisions are taken generally by national entities, these systems have always failed to establish a clear and logical link to the relevant decision centers. The FAP breaks with this tradition and has selected countries mainly on the basis of their importance as decision centers that significantly influence or are affected by the course of the international economy in food and

agriculture. As a consequence, it enables the tracing of international repercussions of national policies, which is a major step forwar in analytical capability.

Our model system differs from many past global models (FAO, 1971; Japanese MAFF, 1974; Takayama et al, 1976; Rojko and Schwartz, 1976; and Lundborg, 1981) in that we distinguish nations and many agricultural subsectors. MOIRA (Linnemann et al, 1977) distinguishes nations but only has one commodity and a restricted set of government policies.

5. A Typical National Policy Model of the FAP

The basic elements of the model system of the FAP are the national policy models. A national model has to reflect the specific problems of interest to that particular nation. Thus the national models differ in their structure and in their descriptions of government policies. The model system of the FAP permits linking of such diverse models but requires that the models meet a few conditions. They have to have a common sector classification at the international trade level, nine agricultural and one non-agricultural sector, and some fairly reasonable additional technical requirements. For example, net exports have to be dependent only on the relative world prices but not their levels and continuous functions of them. Even though the modules of the national models differ from each other, the broad modular structure is common to most models. Each model covers the whole national economy and together they cover the whole world. Thus there are not infinite supply sources or demand sinks in the system to absorb policy impacts and mask meedback and other secondary effects. Food supply and demand are distinguished by various income groups. The broad outline of a typical model is shown in Figure 1.

Past prices and government policies affect production decisions. The domestic production in the n sectors of the economy - $y_1, y_2 \ldots, y_n$ - is the distributed to the various income groups - represented by superscript j. Thus for group j, its

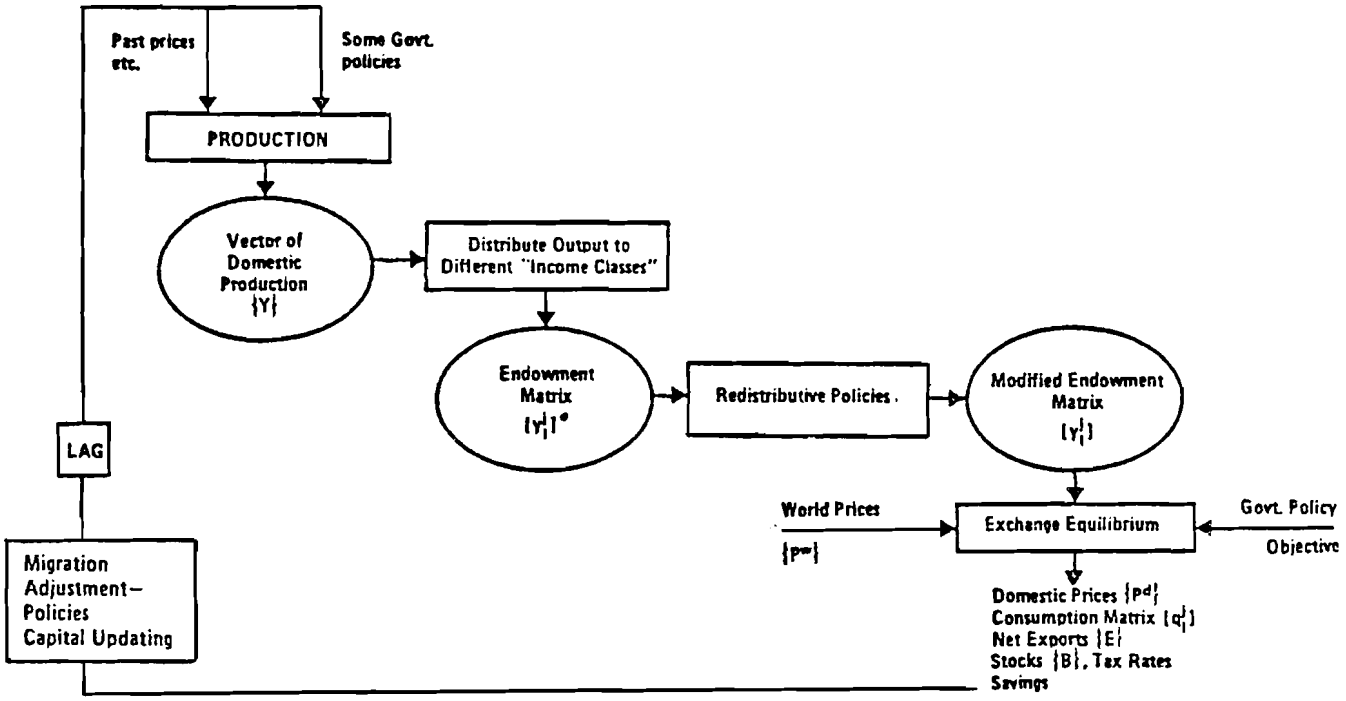

Figure 1. Outline of a typical national model.

share of the national product is given by the vector y_1^j, y_2^j, y_3^j, ..., y_n^j. The income this share amounts to is determined by the price that these products command. For example, a farmer who has grown two tons of wheat and one ton of rice would have an income of twice the price of a ton of wheat plus the price of a ton of rice, minus the cost of producing wheat and rice. The matrix $[y_i^j]$ thus describes the initial endowments of the different products for the various groups.

Given these entitlements and world prices, the $j = 1,\ldots,J$ income groups each of whose demand behavior is characterized by a complete demand system, trade among themselves under the influence of government policies, which include national market policies (price, buffer sotck, trade), public finance policies (balance of payments, public demand, direct tax), and international market and finance policies (agreements on price, buffer stock, trade, financing). The resulting exchange equilibrium determines the domestic prices, net exports, tax rates, and the consumption patterns of different income groups, which clear the markets and meet the balance of trade constraint.

6. The International Linkage

The net exports of all the countries are thus calculated for a given set of world prices, and market clearance is checked for each commodity. The world prices are revised and the new domestic equilibria giving new net exports are calculated once again for all countries. This process is repeated until the world markets are cleared in all commodities. It may be noted that at each stage of the iteration the domestic markets are in equilibrium. The procedure is shown schematically in Figure 2.

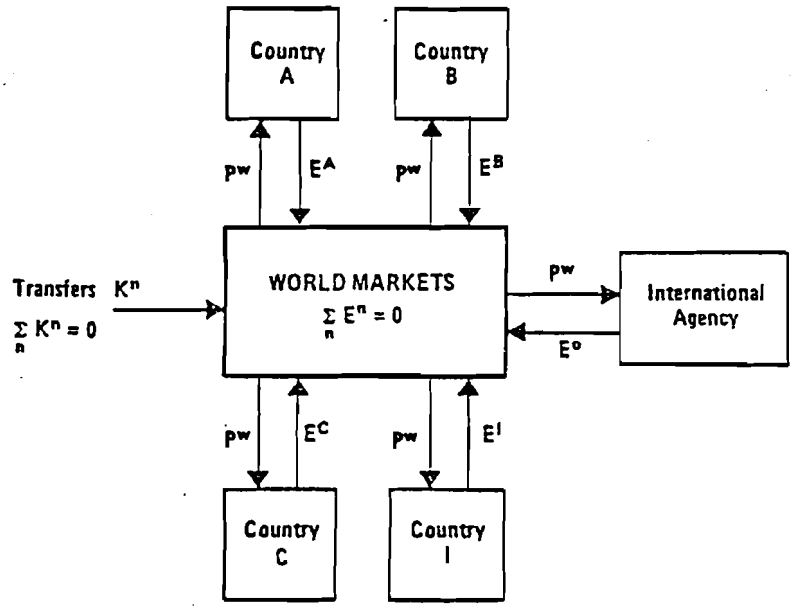

Figure 2. International linkage.

An international agency--such as buffer stock agency--can be represented as a country, and the effectiveness of its policies can be evaluated within a framework in which country policies react to the policies of the agency.

Since we go through these steps period by period, we have a dynamic simulation that we use for a 5 to 15 year period to predict the consequences of various policies, not only for individual countries, but also for the entire system.

This process yields international prices as influenced by government policies. The outcomes of this process are examined by government policy modules whcih may change policies for the next period.

The approach of the FAP model system described briefly above is ambitious, but if the policy issues raised here are to be adequately explored, we believe that such a level of complexity is inescapable.

The countries selected for modeling are shown in Table 8.

Table 8. Countries included in the FAP model system.

Country	Model	Country	Model
Egypt	*	Austria	○
Kenya	*	EC	○
Nigeria	*	Belgium	
Bangladesh	○	Denmark	
China	*	France	
India	*	FRG	
Indonesia	○	Ireland	
Pakistan	*	Italy	
Thailand	○	Netherlands	
Turkey	*	UK	
Argentina	*	Finland	○
Brazil	*	Portugal	○
Mexico	*	Sweden	○
Australia	*	CMEA	*
Japan	*	Bulgaria	
New Zealand	*	Czechoslovakia	
Canada	*	GDR	
USA	○	Hungary	
		Poland	
		USSR	

*Indicates that the model was developed at FAP.
○Indicates that the detailed model is used in the BLS.

7. Some Insights

I would like to now describe some of the insights we have obtained from our studies to date.

a. If only the rich countries ate less and exported more.....

What impact would it have on the hungry people of the poor countries if the rich countries were to eat less and export more, thereby lowering the world prices and allowing the poor countries to import more than they do now?

This was explored by F. Rabar (1981)*. It was assumed that a hypothetical country enters the market and sells 30 million tons of wheat each year, at any price, to help poor importers. 30 million tons is 15% of 1980 cereal export of the world. A series of adjustemtns starts as soon as the first 30 million tons appear on the market. The international market response is immediate. Argentina, Australia, Canada, the US, Mexico and India reduce their export of wheat and Austria, Japan, Brazil, Egypt, New Zealand, the EC, Thailand, Kenya, Pakistan, Nigeria and the rest of the world increase their imports. Our models of CMEA countries, China and Indonesia show no reaction. Yet the quantity is too high to be completely absorbed at prevailing prices. The wheat price drops and it stays depressed for the next ten years.

The second-level adjustment on the part of the exporting countries after reducing their exports, is reducing their production as well. While this happens with different time lags and different intensities, it is the general response of all the exporters.

The second-level adjustment on the part of the importers, after increasing their imports and their home demand, is to reduce their hom production. In other words, they reallocate their production capacities to other products: because of these substitutions, the consumption of wheat increases only marginally and hungry people do not eat much more.

A slight improvement in the nourishment of the population can be observed in some developing countries, but not all.

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*F. Rabar (1981). "Policy Insights from the Basic Linked System". In: Food for All in a Sustainable World.

The real advantage seems to be in the beef market. In almost all countries there is an upward shift in the feed consumption: either wheat is directly used as feed or producers substitute wheat with coarse grain production. Beef production and export figures in the exporting countries and imports in the importing countries go up and for some years after the shock an upswing in beef production is created, until prices and production begin to adjust.

After all these adjustments we may ask the question: where did the additional 30 million tons of wheat, put on the market by an imaginary country go? The answer is that it was absorbed in the system. Almost none of it reached the hungry people in the countries represented.

What we learn is that private asceticism alone, howsoever sincerely persued is not likely to work.

b. <u>May be increased food supply on the world market does not help the poor, but what if we were to give food aid to poor countries.....</u>

Though food aid increases the availability of food in the country, it also depresses prices and lowers incentives for food production. The economic literature is full of controversies on the effects--beneficial or otherwise--of food aid. To appreciate the complexity of evaluating the effects of food aid, as an example, consider its impact on the growth of the economy of a developing country. The outcome would depend on government policies. Faced with a food shortage, a country may decide not to accept food aid but to ration food to deal with the deficit. In such a case the unsatisfied demand for food from those who could afford to buy more would be redirected toward consumption of other goods, which may reduce exports of these goods and lead to reductions in investment and food output in the future. However, were the country to accept food aid and distributed it only to the poor at subsidized prices, it would improve their well-being but have little or no impact on market prices and no impact on future output. It is difficult to identify the poor though, and the food might be distributed

to all citizens living in given areas--mostly urban areas. This would lower market prices of food, reduce farmers' incentives to produce, and might lead to lower future output. But if the food aid constitutes aid in addition to what the country might otherwise receive, it would permit the government to promote increased investment. If the government does in fact increase investment, this could, if directed to agriculture, give a higher output in the future. The outcome in a particular instance would thus depend on the totality of government policies.

We have begun to explore this issue in its proper setting with our set of models where the various government policies and their impact on consuemr and producer behavior is accounted for. We expect to identify the specific set of policy measures that would minimize the negative effects of aid while benefiting from its positive effects.

c. Would not domestic economic growth eliminate hunger, or do we need growth and redistribution?

Per capita food production has grown in India at an annual rate of 1% over 1950-1980, and yet the percentage of rural population below the poverty line with insufficient food has remained more or less constant. To test the effectiveness of redressing poverty and malnutrition through what we call a "free food program", in which the government annually distributes freely to everyone 75kg of food grains, the model of India was used by Parikh and Narayana (1981)*.

The questions that arise are the following:

- o What would be the impact on poverty, on consumption, and on income distribution?
- o What would be the impact on the government budget, its budgetary surplus and public investment and consequently the impact on the growth rate of the economy?

*"An Agricultural Policy Model for India - An Illustrative Exploration of a Right to Food Program". In: Food for All in a Sustainable World, op.cit.

- What would be the impact on domestic market prices of food grains and their impact on supply?

The simulation is carried out up to 1990--where the policy changes are introduced in 1977. Four scenarios are generated to explore the issues.

Between the base and the free food scenarios a fall in growth rate of real GDP of about 0.7% per year is observed. A major impact of the program is in the distribution of consumption. Under the free food program the number of people in absolute poverty drops to around 10 million in 1977 from its 1976 level of more than 160 million people in the rural areas. When we compare the base scenario to another one in which the growth rate of the economy is higher but without a free food program we see no change in poverty levels. So growth alone is not enough to reduce poverty. It is clear that such a free food program can be very effective in reducing poverty. Its cost is lowered growth. A reduction of 0.8% in growth rate from the base case rate of 4.6 may seem acceptable to many. But a reduction from an average annual growth rate of 3.5% as achieved by India over the past three decades may not be so obviously acceptable. The growth rate in our base case is higher than actual because of our assumption of reduced capital/output ratios in the non-agriculture sector. Thus, if growth is stepped up, redistribution becomes easier but it is still necessary to redress poverty.

d. <u>If redistribution policies are the key to a speedy elimination of hunger, what can the developed countries do?</u>

It is true that redistributive policies are mainly in the hands of national governments, but developed countries can by their actions greatly facilitate developing countries in following redistributive policies. Though we have yet to explore such policies with our models, a number of interesting policies with far-reaching consequences can be considered. Among such policies are the following:

(i) Freer immigration. Many developed countries forget that their path to development was greatly facilitated by the much freer borders that existed before the First World War. Poor Europeans emigrated to the Americas, Australia, and to colonies in Africa making it easier for those left behind to improve their lot. Even in recent decades the contribution to the "development" of southern European countries of the remittances by the "guest workers" in northern Europe has been significant The remittances by Asian and African workers in the Middle East have been of considerable importance for many developing countries, particularly in surviving the oil price shocks of the Seventies. Though I do not know of firm estimates of transfers by "guest workers" and immigrants, they are likely to exceed significantly the flow of official aid to developing countries.

We intend to explore with our model system implications for all nations of easier migration.

(ii) Increased aid. "Guest workers" not only are "workers", they are people too. And this causes social tensions in countries which admit many guest workers. Thus freer immigration does not find political acceptance in many developed countries. Yet it would be interesting to examine what level of capital transfer could generate the same effects as freer immigration. Unfortunately, the aid flows are shrinking from their meagre levels. But if capital aid is to be directed to reducing hunger and not just through trickle down effects of faster growth, the developed countries should demand approrpirate allocations and redistributive actions from aid recipients in return for much larger aid. Of course, such policies should be carefully worked out. At least those developing countries who claim to want to eradicate poverty should not object to such tied aid as long as the actions demanded are directed to accomplishing their own professed objectives.

(iii) Freer access to markets. Given greater access fo the developed country markets, many developing countries could increase their exports and grow faster. Yet developed countries protect their domestic producers and raise trade barriers. At least in agriculture, the degree of protection is higher in countries with higher per capita income, and the richt protect the most. Removal of such barriers may promote agricultural growth in many developing countries if the LDCs in turn were to adapt their policies to exploit fully their comparative advantage. This could make a significant impact on poverty and hunger in these countries.

But the protection of agriculture, by EC for example, also helps developing country food importers. These countries may need additional aid to compensate them. Such policies thus need to be explored in a global modeling system like FAP's which distinguishes nations and their policies.

(iv) Concern for effects of developed countries' policies on developing countries. Domestic policies of developed countries affect the food situation in developing countries, and the former should be sensitive about these impacts, particularly about the impacts on hunger in poor countries. Such effects can be asymmetric. For example, when US or EC policies raise wheat price on the international market, the poor in LDC's may get less to eat but when their policies lower wheat price internationally, it may make no impact on the poor. To show that such concerns are not theoretical but of significant impact we report on two runs made with our system of models:

What if the US were to spend less on agriculture research and reduce growth rates of yields of some food grains.....

Reduced expenditure on agricultural research may reduce rates at which yields of soyabeans, maize and wheat increase in the US. Such changes would affect acreage allocations in the US, its exports and world prices. The impact would be global. This was explored with our US model (Abkin, 1981)* linked to our basic linked system.

*Abkin, M.H. (1981) "The Basic US Model for the IIASA/FAP Global System of Food and Agriculture Models: Domestic Utilization and Prices". WP-81-38, IIASA, Austria.

The yields of soyabeans, maize and wheat grow by 1.83, 1.68, 2.06 percent per year, respectively in the base run. We assumed that climate disturbances would lower these rates to 0.93, 1.54 and 1.61, respectively from 1982 onwards. The effects were predictable but the magnitudes somewhat surprising. Though the US yields in 1990 were lowered by 8.3%, 0.82% and 4.1% for soyabeans, maize and wheat respectively, their US outputs reduce by only 6.75%, 1.87% and 2.56%, and the world production changes even less. It is interesting to note that the area under maize increases, whereas areas under soyabeans and wheat decrease. The world prices of soyabeans are higher in all years from 1982 to 1990, but the prices of maize and wheat are lower in some years though higher in most years. Meat prices are also higher. Adjustments in production structures in the US and other countries somewhat soften the impact of such changes. The above runs can also be interpreted to show what if climate changes were to slow down growth of soyabeans, maize and wheat in the US.

What if the US were to raise the price of its grain exports...

A bill proposed to the US Congress would raise the price of exported wheat and maize to "the cost of production", a technical US agriculture term that is calculated on a generous basis. What would be the consequence of such a bill on prices, production and farmers' incomes? This has been explored with the help of our US model linked to our basic linked system. One expects that:

- The US prices would rise to the "cost of production"
- The world price would rise to the US price less transportation differentials. This would happen because the price rise is low enough and the US is an important enough supplier so that the US would still export
- There would be large acreage restrictions imposed on the US production of maize and wheat
- The acreage restrictions and higher prices could affect farmers incomes either way depending on the net impact of loss in production and gain in prices.

- o The effects of coarse grains exports from the US would be slightly moderated by substitution to other feed grains
- o Non US production of wheat and coarse grains would increase. The extent of this is the main key to whether US farmers would be helped or hurt
- o The US would expand its production of other agricultural commodities perhaps especially rice
- o As the model is now set up the US price of meats would rise, reducing consumption.
- o In any case one would expect the US economy to lose but what would be the extent of such loss?

Without linkage to models of other countries provided by our basic linked system, it would have been difficult to explore this issue. Runs made with the US model in a stand-alone mode would fail to show the effects outside the US where exporting nations, or those nearly ready to export, would be helped while importers would be hurt. But more eimportantly, the impact of the feedback from other countreis of the world on the US would have to be captured by an export demand function. Even when reasonable estimates of these are available, and they are rare to find, changes in them, due to policy adjustments of other countries subsequent to US policy changes would be hard to capture in such an unliked run. Our model runs show that such a policy could cost US economy billions of dollars though it would raise the US farm incomes somewhat. World prices of these commodities rise and the imports of poor countries get reduced.

These two runs clearly demonstrate that US policies (and similarly policies of other developed countries) affect food situation in developing countries. Such impacts should be evaluated in setting domestic policies. Our modeling system provides a tool for such evaluations.

8. Long Term Prospects and Policies

The world has adequate resources to feed mankind now and in the future. Estimates of the population supporting capacities of the developing countries of the world based on agro-climatic data show that most developing regions, though not all countries, have adequate potential to support projected populations by 2000. These results, summarized in Table 7, show that the land of the five regions together could, even with low level of inputs, meet the food needs of 2.0 times the year 1975 population and 1.5 times the food needs of the projected year 2000 population. Even individually the regions have the potential to be self-sufficient using low level of inputs excepting South West Asia which would need high level of inputs.

Table 9. Potential/Present Population Ratios Under Alternative Technologies.

LEVEL OF INPUTS	AFRICA	SOUTHWEST ASIA	SOUTH AMERICA	CENTRAL AMERICA	SOUTHEAST ASIA	AVERAGE
YEAR 1975 POTENTIAL: PRESENT POPULATION RATIOS						
Low	2.8	0.8	5.9	1.6	1.1	2.0
Intermediate	10.8	1.3	23.9	4.2	3.0	6.8
High	31.6	2.0	57.2	11.5	5.1	16.3
YEAR 2000 POTENTIAL: PROJECTED POPULATION RATIOS						
Low	1.5	0.7	3.5	1.4	1.1	1.5
Intermediate	5.4	0.9	13.3	2.6	2.3	4.1
High	15.5	1.2	31.5	6.0	3.3	9.1

Source: Higgins, Kassam and Naiken (FAO), Shah (IIASA and Calderoni (UN), "Can the Land Support the Population - the Results of a FAO/UNFPA/IIASA study, "Land Resources for Populations of the Future" POPULI, UNFPA, N.Y., Vol.9, 1982.

With high level of inputs the potential population supporting capacity of the developing countries is 9 times the projected population of the year 2000. The results shown in this table are from a study carried out by FAP of IIASA jointly with FAO and UNFPA. Soil data at the level of units of 10000 hectares with climatic data were evaluated from agronomic principles to

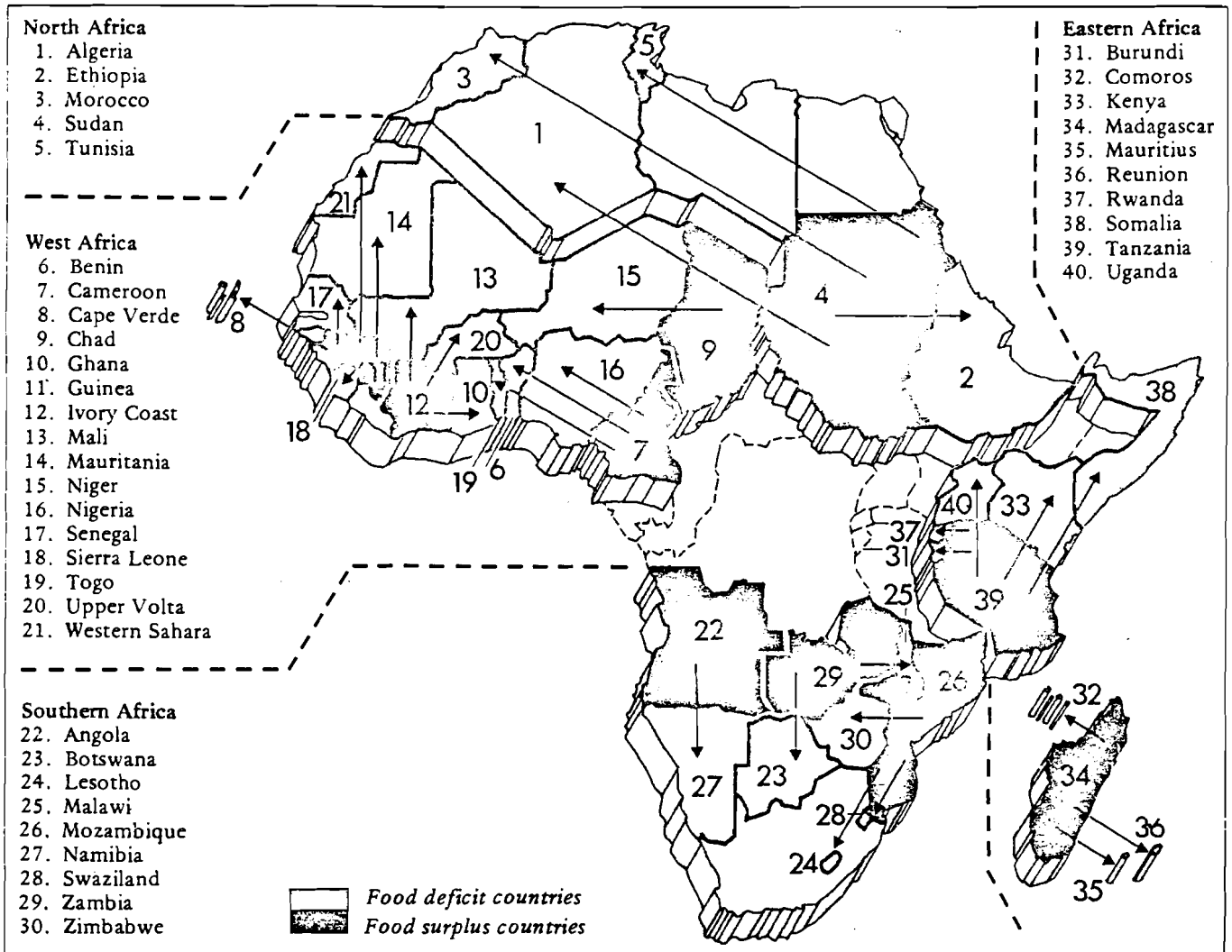
arrive at crop production potential for various suitable crops. These were further processed to construct various scenarios for agricultural production for different countries. These evaluations give us guidance on the following:

- How does the country's cropping pattern reflect its natural advantages?
- Which areas and which crops offer the most chance for further development?
- How much resources would be needed to realize desired growth potentials.

When looked at from the point of view of a number of neighboring countries, this study also indicates which groups of countries could together have the potential to become self-sufficient in food. As an example we show the results of Africa. Although Africa has the potential to sustain more than one-and-one-half times the projectec population at the low level of inputs, there are thirty countries (designated as "critical") that do not have sufficient land resources to produce domestically the food requirements of their projected population of some 200 million people. However, if the countries were to trade and cooperate on a regional basis (see Figure 3), the regional food self-sufficiency and self-reliance could be viable.

It should be emphasized, however, that these estimates are for agronomic potentials and do not tell us how much it will cost to realize them. The large agricultural potential of developing countries would require much resources of capital, knowledge, skills and organization. The scope for external assistance from governments and industry is large, and unless it is mobilized today's hunger problem will remain with us for a long time.

Even when resources are available to develop agricultural production potential, countries would need to decide which sectors and commodities it should develop first. These decisions depend critically on what the global perspective of development is and what would be the comparative advantage of the country



Although the Africa region as a whole has the potential to sustain more than one-and-one-half times its projected population in the year 2000, there are some thirty "critical" countries with insufficient land resources to meet the food requirements of the projected population domestically. However, trade and cooperation on a regional basis between countries with food surpluses and food deficits would allow for regional food self-sufficiency and self-reliance.

Source: Annual Report 1982, International Institute for Applied Systems Analysis.

Figure 3. Scope for regional cooperation in Africa.

in the coming years. The comparative advantage of a country changes over time and is affected by its investment allocation decisions. Moreover, they are also affected by such decisions of other countries. Thus even to plan a national agricultural strategy one needs to understand the prospective development of the world's agricultural system and an appreciation of the evolving comparative advantage.

Once again the IIASA-FAP modeling system provides a unique tool to provide such a perspective. Moreover, it can also help evaluate issues of major policy concern to many developed countries that can significantly affect the evolution of the world agricultural system.

We propose to explore one such issue, the desirability and alternative strategies of trade liberalization, with our modeling system.

Trade Liberalization, Strategies for Transition to Free Trade:

Many developed countries protect their farmers. In general richer countries protect their farmers more. Removal of such protection could be beneficial for many countries and yet no country may want to make a beginning. A number of hypotheses has been advanced:

- Trade liberalization is not costly provided it is a gradual and balanced reduction in protection. The reductions should be balanced among commodities and balanced among countries.
- If all the major countries were to move to reduce protection in a number of commodities simultaneously, then adjustment costs would be smaller than what would be were only one of them to move or only one commodity were to be unprotected.
- Trade liberalization would reduce instability on international markets.

These hypotheses need to be tested. To do so we need to answer the following questions:

- What would happen to production, consumption, trade, prices, farm incomes and government incomes in different countries in the event of elimination of trade and production restrictions? Immediately and after some years?
- What would be such impacts when only one country were to liberalize? When all countries were to liberalize in only one commodity? In all commodities?
- What maximum rate of reduction in protection would limit reduction in farm incomes to a preset limit, say 2 percent per year?

- What would be the impact on LDC's and particularly the poor in them? Does one need to design special protection measures for them even when the developed world moves towards free trade?

Through a fuller understanding of consequences of one's policies and actions we could hope to move the world to a better future for all.

Concluding Observation

The problem of providing food to all now and in future, meeting the most basic of the basic needs, is a complex but solvable one. Yet hunger exists today and will exist tomorrow unless we all act, with increased understanding of the complexity of the problem, with hard-headed realism of what policies work and how, and with goodwill and generosity.

REFERENCES

Abkin, M. (1981) The Basic U.S. Model for the IIASA/FAP Global System of Food and Agriculture Models: Domestic Utilization and Prices. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Ahluwalia, M.S. (1978) Rural Poverty and Agricultural Performance in India, Journal of Development Studies, Vol. 14, April 1978, pp.298-323.

FAO, Food and Agriculture Organization of the United Nations, A World Price Equilibrium Model, Projections Research Paper No. 3, CCP72/WP3, Rome (1971).

The Fourth World Food Survey, 1977. Table 1.3.1, page 16. FAO, 1977.

Japan, Ministry of Agriculture and Forestry, Outline of the World Food Model and the Projections of the Agricultural Products for 1980, 1985, Tokyo (1974).

Linnemann, H. J. de Hoogh, M.A. Keyzer, and H.D.J. van Heemst, (1977) MOIRA: Food for a Growing Population, CP-77-1, Laxenburg, Austria: International Institute for Applied Systems Analysis.

Lundborg, P., Trade Policy and Development: Income Distribution Effects in the Less Developed Countries of the US and EEC Policies for Agricultural Commodities, Ph.D. dissertation, Department of Economics, University of Gothenburg, Göteborg (1981).

Parikh (1977) A Framework for an Agricultural Policy Model for India. RM-77-59. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Parikh, K.S. and Ferenc Rabár (1981) Food for All in a Sustainable World: The IIASA Food and Agriculture Program. SR-81-2. Laxenburg, Austria: The International Institute for Applied Systems Analysis

Rojko, A.L. and M.W. Schwartz, Modeling the World Grain-Oilseeds-Livestock Economy to Assess World Food Prospects, Agricultural Economics Research, 28(1976), pp. 89-98.

Takayama, T., and H. Hashimoto, Dynamic Market-Oriented World Food Projections and Planning Models and Their Empirical Results for the 1970-1974 World Food Situation, World Food Projections Report No. 2, Department of Agricultural Economics, University of Illinois, Urbana-Champaign, Illinois (1976).

The World Bank (1980) World Development Report. Washington, D.C.